MONTANA DEPARTMENT OF FISH, WILDLIFE, & PARKS
ECOLOGICAL SERVICES DIVISION

JOB PROGRESS REPORT

STATE: Montana
PROJECT NO. FW-3-R-10
JOB NO. 1-a Fisheries

TITLE: Middle Missouri River Planning Project

PERIOD COVERED: July 1, 1981 through June 30, 1982

ABSTRACT

A fishery inventory and planning study was continued on the blue ribbon portion of the Missouri River from Holter Dam to the confluence of the Smith River. Twenty species representing eight families of fish occur in this study area. Rainbow and brown trout and mountain whitefish are the most common game fish, and they comprise the bulk of the sport fishery.

Electrofishing surveys indicate rainbow and brown trout and mountain whitefish utilize tributaries for spawning. Tag returns indicate some trout move considerable distances in the Missouri River to reach spawning tributaries. Tributaries provide important rearing habitat for trout. Trout and whitefish also use the mainstem of the Missouri for spawning and rearing. Tributaries are relatively more important for rainbow spawning and rearing, while side channels of the Missouri are relatively more important for brown trout.

Creel survey in 1981 indicated anglers caught 0.41 trout/hour in the Missouri River. Catch rates ranged from 0.16 trout/hour in May to 0.64 trout/hour in October. Brown trout comprised 18.6 percent of the catch at Cascade compared to only 1.5 percent at Holter. Boat fishermen caught 0.61 trout/hour, while bank fishermen caught 0.38 trout/hour. Anglers have harvested 5.49 and 5.70 percent of the rainbow and brown trout tagged in the study area.

Work was completed on an instream flow study for the Missouri River. In addition, data were collected on water temperatures, aquatic macroinvertebrates, fish larvae and forage fish.

BACKGROUND

A basic inventory is essential in formulating management plans for maintaining and utilizing the fishery resources of a given area. Seldom is this information complete for an entire area or drainage. The Missouri River from Holter Dam to the

confluence of the Smith River supports a cold water fishery of considerable significance, and prior to this study, basic data on the aquatic resources of this area were lacking.

Because of the increasing demand for Montana's limited water supplies for hydropower, irrigation, industrial and domestic uses, water resource development proposals for this section of the Missouri River appear likely. Proposals which remove significant amounts of stream flow or modify existing flow regimes could ultimately affect the fishery resource and the associated aquatic community. Unless stream flow levels necessary to maintain the aquatic resources of the middle Missouri River are determined, little can be done to evaluate conflicting demands and minimize adverse impacts on the fishery. For these reasons the Montana Department of Fish, Wildlife, and Parks (DFWP) initiated this study on April 1, 1980.

DESCRIPTION OF STUDY AREA

The study area lies in north central Montana and includes a 99.0 kilometer (km) (61.5-mile) reach of the mainstem of the Missouri River from Holter Dam to the confluence of the Smith River. Four study sections, Craig, Hardy, Cascade, and Ulm were established in this reach (Figure 1). In addition, limited studies were conducted on the lower reaches of the Dearborn River, and Little Prickly Pear, Sheep, Rock, Stickney, Hardy, and Wegner creeks. These are the principal tributaries to the Missouri River in the study area. The tributaries add considerable flow to the Missouri during spring runoff, but they contribute very little flow during the remainder of the year.

The Missouri is the nation's longest river, 3982 km in length from its origin at Three Forks, Montana, to its confluence with the Mississippi River at St. Louis, Missouri. The river segment covered by this study represents one of the last free-flowing reaches of the entire river. Most of the Missouri River has been impounded by dams and reservoirs.

The river flows in a north easterly direction through two distinct geologic zones in the study area. From Holter Dam to the confluence of Sheep Creek, a distance of 38.7 km, the river flows through a mountain canyon having an average width of 1,000 m. The Big Belt Mountains lie to the southeast, while the east front of the Rocky Mountains lies to the northwest. A narrow band of riparian vegetation consisting primarily of willow and some cottonwood lies along the riverbanks. Several brushy islands surrounded by extensive side channels are found in the upper portion of this reach between Holter Dam and the confluence of the Dearborn River (Craig study section, Figure 1). From the Dearborn River to the confluence of Sheep Creek, the river is confined by precipitous rock cliffs and other hydraulic controls to a single, deeper channel with very few islands and side channels (Hardy study section, Figure 1). Below the confluence of Sheep Creek, the river abruptly leaves the mountain area and meanders through a wide and generally flat prairie zone. The upper portion of this zone, from Sheep Creek to Cascade, is characterized by well defined pools and riffles with some large brushy islands and side channels (Cascade study section, Figure 1). The lower segment of the prairie zone, from Cascade to the confluence of the Smith River, is characterized by a deep meandering channel with very few riffles. Several old oxbows have created shallow sloughs and backwater areas in this reach (Ulm study section, Figure 1). Extensive growths of riparian vegetation consisting of a willow/cottonwood overstory are found on the floodplain throughout most of the prairie zone.

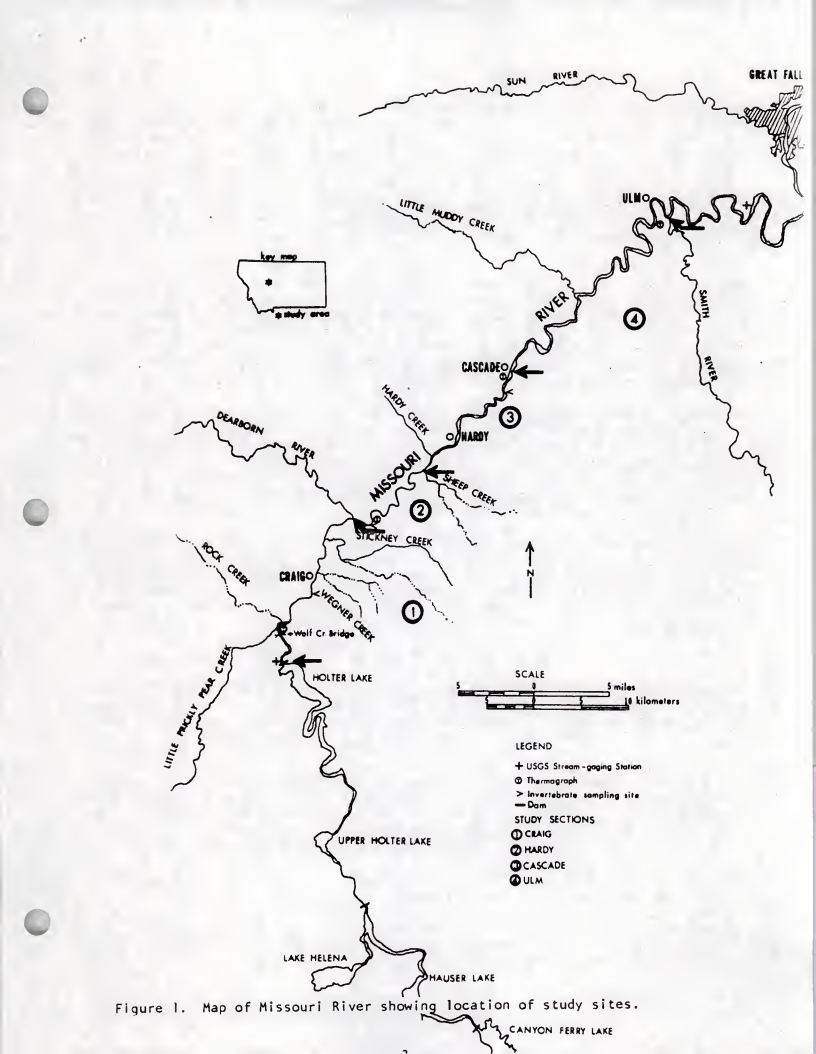

Figure 1. Map of Missouri River showing location of study sites.

The 99.0-km reach of the Missouri River from Holter Dam to the confluence of the Smith River is classified by the Montana Fish and Game Commission as a blue ribbon trout fishery (Brown et. al., 1959). This is one of the longest single reaches of blue ribbon trout stream in Montana, and it represents 14 percent of the state's 727 km (452 miles) of blue ribbon water. An excellent fishery exists in this area for trophy-sized rainbow and brown trout. Many trout from 2.3 to 4.5 kilograms (kg) (5 to 10 pounds [lb]) are taken each year as well as a good number of trout larger than 4.5 kg. Fish larger than 4.5 kg are predominantly brown trout. Mountain whitefish are several times more abundant than trout and provide an important winter fishery.

Many species of waterfowl are seasonally associated with the river. Mallards, mergansers, Canada geese, and teal nest along the river on islands, backwater areas, and sloughs. Some mallards, goldeneyes, and geese spend the winter in ice-free areas along the river. During spring migration, the river is often an important resting area for thousands of pintails, mallards, and other waterfowl enroute to northern nesting areas. Several species of shore birds such as killdeer, snipe, phalarope, and gulls are also seasonally associated with the river.

The extensive riparian vegetation along the lower half of the study section provides excellent habitat for many important wildlife species. Large numbers of white-tailed deer, mule deer, and ring-necked pheasant are found here year-around. Small patches of riparian vegetation along the river in the mountain canyon area also provide habitat for a few deer. Mink, muskrat, beaver, raccoon, and a few river otter are found throughout the study section. Bald eagles are often observed along the river corridor during the winter.

Access to the river is good throughout the study area. There are several public access areas along the upper half of the river. Old U.S. Highway 91, now designated as a recreation road, parallels considerable portions of the river and also provides easy access. River flow is always good for floating, and many recreationists take advantage of this sport. The outstanding scenery and fishing add to the enjoyment of this activity.

OBJECTIVES AND DEGREE OF ATTAINMENT

The long range objective of the study is to follow inventory procedures developed in earlier studies (Wipperman 1973, Berg 1975 and 1981a) and use the resulting data to prepare recommendations for aquatic resource management on this section of the Missouri River. Specific objectives during this report period were:

(1) Continue to conduct baseline surveys of resident adult fish populations in four study sections of the Missouri River from Holter Dam to the confluence of the Smith River to determine species composition, longitudinal distribution, relative abundance and size composition of the populations. The four study sections are located on the Missouri River in the vicinities of Craig, Hardy, Cascade and Ulm.

(2) Obtain spring and fall estimates of rainbow and brown trout populations in the Hardy study section using a mark/recapture technique.

(3) Continue to identify and monitor spawning migrations of rainbow and brown trout in the Missouri River mainstem and in the lower reaches of the Dearborn River, Little Prickly Pear Creek, Sheep Creek and Rock Creek.

(4) Continue to attempt to locate spawning sites of rainbow and brown trout by searching for redds. Determine the conditions required for successful spawning by measuring physical parameters including water depth, velocity and substrate composition of the redds. Attempt to determine time of emergence of larval trout from redds by sampling with appropriate equipment.

(5) Continue to tag key fish species in the Missouri River below Holter Dam with individually numbered tags to determine angler harvest, monitor movements of individual fish and establish home ranges.

(6) Continue to conduct a partial creel survey on the mainstem of the Missouri River to determine success rate, species composition and size composition of the catch.

(7) Continue to conduct baseline surveys in the lower reaches of the Dearborn River, Little Prickly Pear Creek, Sheep Creek and Rock Creek to determine the importance of these tributaries as rearing areas for juvenile rainbow and brown trout.

(8) Complete sampling for aquatic macroinvertebrates at four stations on the Missouri River to determine taxonomic composition and longitudinal distribution. The macroinvertebrate sampling stations are located in the Craig, Hardy, Cascade and Ulm study sections.

(9) Continue to collect forage fish samples in conjunction with adult fish population surveys to determine species composition and longitudinal distribution of forage fish.

(10) Complete analysis of wetted perimeter cross-section data gathered on the Missouri River in 1980. Attempt to derive instream flow recommendations from the data.

(11) Continue to conduct baseline surveys in side channels of the Missouri River to determine the amount of instream flow required to maintain trout rearing habitat.

(12) Locate a minimum of 10 viewpoint sites on the mainstem of the middle Missouri River and photograph the river at each of the sites at a variety of flow levels. Attempt to derive instream flow recommendations from the photo series.

(13) Maintain thermograph stations at four sites on the Missouri River below Holter Dam. The thermograph sites are located in the Craig, Hardy, Cascade and Ulm study sections.

(14) Continue to supervise BLM-funded instream flow study on the Missouri River from Morony Dam to Fort Peck Reservoir. Prepare annual study proposal and budget for this study and assist with preparation of annual report.

(15) Prepare instream flow applications for the Missouri River from Morony Dam to Fort Peck Reservoir and from Holter Dam to the mouth of the Smith River.

Progress was made on all of the objectives. Findings are presented in the appropriate sections of this report.

PROCEDURES

Water Temperature

Thirty-day continuous recording thermographs were used to monitor water temperature. The recorder box was positioned on the streambank as far above the high water mark as possible. A thermocouple lead, varying in length from 8 to 23 m, was extended into the water through flexible, plastic sewer pipe.

Macroinvertebrates

Aquatic macroinvertebrate samples were collected using a rectangular framed 20 x 45 cm, conical net kick sampler with fine mesh (300 micron) pores. The net was positioned on the streambed so the current flowed into it. Macroinvertebrates were washed into the net by an operator standing in front of the net kicking into the substrate. A variety of habitat types (cobble, gravel, sand, submerged vegetation, etc.) were sampled at each station to obtain a representative sample. Samples were transferred to jars containing an identifying label and preserved with 10 percent formaldehyde.

Larval Fish

Drifting larval fish were sampled with a 0.5 m diameter by 1.6 m long Nitex plankton net (750 micron mesh) fitted with a threaded ring sewn at the distal end to accomodate a wide mouth, pint mason jar as the collecting bucket. The net was fished in a stationary position immediately below the surface of the water in main channel border areas of the river. The net was anchored in position in the current by a 4 m length of rope. The net was fished for a measured period of time, usually 30 to 60 minutes. On some occasions the net was fished for less than 30 minutes because of excessive amounts of debris collecting in the nets.

Larval fish located near the border of the stream channel were sampled with a hand-held rectangular framed 25 x 45 cm, conical shaped dip net with fine mesh (300 micron) pores. Since Salmonidae larvae rarely are found in drift samples, this technique was utilized principally to collect Salmonidae.

After the net was retrieved from the river, its contents were thoroughly washed into a collecting jar containing an identifying label. Samples were preserved in a 10 percent solution of formaldehyde colored with phloxine-B dye, a deep pink coloring agent which penetrated the fish larvae and aided in separating them from aquatic vegetation and debris. Larvae were identified to the lowest taxon practical using keys by Hogue et. al., (1976) and May and Gasaway (1967). For purposes of this study, larval fish were defined as those fish exhibiting undeveloped pectoral, anal, and dorsal fin rays, essentially as suggested by May and Gasaway (1967).

Juvenile and Adult Fish

Boom-suspended Electrofishing System

A boom-suspended electrofishing system was used to sample fish populations on the mainstem of the Missouri River. The electrofishing system was adapted from Novotny and Priegel (1974) and is described by Berg (1981a). The electrofishing apparatus was mounted on a 4.5 m (14.6 foot) aluminum drift boat powered by a 9.9 horsepower outboard.

The boom-suspended electrofishing apparatus was the most effective technique for sampling fish in the Missouri River mainstem. Other procedures such as mobile electrofishing and seining were effective only in restricted habitat areas such as shorelines, backwaters, and side channels.

Mobile Electrofishing System

A mobile electrofishing system was used to sample juvenile and forage fish in shoreline and side channel areas of the Missouri River. The system was also used to sample adult, juvenile, and forage fish in tributaries of the Missouri. The mobile electrofishing system consisted of a hand-held mobile positive electrode, a stationary negative electrode mounted on a 1.0 m^2 float attached to the boat, and a portable 1350-watt, 115 volt (60 Hz. single phase) alternating current generator. A Coffelt Model VVP-2C rectifying unit was used to change the alternating current to pulsed direct current. Output from the rectifying unit was adjustable from 0 to 300 volts half-wave 60 hz. in 25 and 50 volt increments. The electrofishing system was carried in a 5.8 m (19 foot) aluminum freight canoe. In tributaries where the freight canoe could not be floated, electrofishing with this system was accomplished by bank shocking with 76.2 m (250 feet) of 16/2 electrical cord.

Fish Sample Processing and Tagging

Fish captured by various methods were measured to the nearest mm in total length and weighed to the nearest 10 g. Sex and spawning condition (gravid, ripe, or spawned) were recorded for fish captured during their spawning season. Several thousand catchable game fish were marked with individually numbered Floy t-tags to evaluate growth rate, movement, and angler harvest. All fish were released near the capture site.

Fish Population Estimates

Population estimates were made using the Petersen mark-recapture formula as modified by Chapman (1951):

$$N = \frac{(M+1)(C+1)}{(R+1)} - 1$$

where: N = population estimates
M = the number of marked fish
C = the number of fish in the recapture sample
R = the number of marked fish in the recapture sample (C)

Multiple marking and recapture runs were needed to collect an adequate sample size. A partial fin clip or fin punch was used to mark the fish. A minimum of two weeks was allowed before recapture runs were made. Additional methods used for population and standing crop estimates are described by Vincent (1971 and 1974).

Fish Aging

Scales were collected from some fish for age determination. The scale samples were imprinted on an acetate slide, and the imprints were projected at 44X with a Bausch and Lomb optical projector. Annuli were identified and ages assigned following procedures described by Tesch (1971) and Lagler (1956).

Missouri River Creel Survey

An angler creel survey was conducted on the sport fishery which exists on the Missouri River from Holter Dam to the confluence of the Smith River. The survey was a partial census in which interviews of fishermen were used to obtain estimates of angling data. With a postcard-sized survey form, partial trip data were obtained during interviews with individual anglers (Figure 2). The interview form was recorded in duplicate, with the original copy retained by the census taker and a carbon copy given to the angler. Upon completion of his/her fishing trip, the angler voluntarily recorded complete trip data and returned the postpaid carbon copy of the interview form.

FINDINGS - PHYSICAL CHARACTERISTICS

Drainage Area and Stream Discharge

The drainage area of the middle Missouri River increases from 44,416 km^2 to 54,237 km^2, or by about 29 percent, between Holter Dam and the confluence of the Smith River (USGS 1979). The climate is characterized by moderately low rainfall, a dry atmosphere, hot summers, cold winters, and a large proportion of sunny days.

Streamflow is monitored by the USGS at gages located 0.6 km downstream from Holter Dam (Holter Dam gage) and 14.6 km downstream from the confluence of the Smith River (Ulm gage). Mean annual discharge for a 33-year period of record at Holter Dam is 4.99 km^3/yr (4,051,000 acre-feet/year) compared to 6.09 km^3/yr (4,938,000 acre-feet/year) for a 21-year period of record at the Ulm Gage (USGS 1978). The maximum flow recorded at Holter Dam was 986 m^3/second (34,800 cfs) on June 8, 1948, while the maximum at Ulm was 779 m^3/second (27,500 cfs) on June 22, 1964.

Present day flow regimens of the Missouri River are not natural because of regulation and storage at several dams in the drainage upstream from the study area. Flow is largely controlled by Canyon Ferry Reservoir, the largest of three consecutive upstream reservoirs. Canyon Ferry was completed in 1953, and it is operated by the U.S. Bureau of Reclamation for irrigation, hydropower, flood control, recreation, and supplemental water supply for the City of Helena. Canyon Ferry has a surface area of 14,245 hectares (35,200 acres) and a storage capacity of 2.529 km^3 (2,051,000 acre-feet). Hauser and Holter reservoirs lie downstream of Canyon Ferry Dam and provide head for power generation (Figure 1). Hauser and Holter dams are owned and operated by Montana Power Company.

Stream Gradient

The Missouri River enters the study area immediately below Holter Dam at an elevation of 1056.1 m (3,465 feet) msl, dropping 44.2 m (145 feet) to an elevation of 1011.9 m (3,320 feet) msl near the confluence of the Smith River (Table 1). Stream gradient averages 0.39 m/km (2.04 feet/mile) and varies from 1.49 m/km (7.84 feet/mile) at Halfbreed Rapids to 0.10 m/km (0.52 feet/mile) near Ulm (Figure 3). Stream gradients were determined by measurements taken from USGS topographic maps.

Table 1. Stream gradients of the Missouri River from Holter Dam to Black Eagle Dam at Great Falls, MT.

River Kilometer	Approximate Location	Elevation (meters, msl)	Gradient (m/km)	Gradient (ft/mi)
0.0	Black Eagle Dam	1005.8	-	-
5.0	BN RR Bridge at Gr. Falls	1008.9	0.67	3.22
36.0	Ulm	1011.9	0.10	0.52
93.3	Cascade	1018.0	0.11	0.56
107.9	Finigan Creek	1024.1	0.42	2.21
112.0	Sheep Creek	1030.2	1.49	7.84
121.0	Andy Creek	1036.3	0.67	3.56
126.4	Mid-Canon	1042.4	1.14	6.01
135.1	Craig	1048.5	0.70	3.68
146.0	L. Prickly Pear Creek	1054.6	0.56	2.96
150.3	Holter Dam	1056.1	0.35	1.87

MISSOURI RIVER CREEL CENSUS (Holter to Ulm)

Date _____ Interview _____

Location _____ Holter, Craig, Hardy, Cascade, Ulm

No. Persons In Party _____ Bank/Boat

Where From _____

Type Of Tackle _____ Artificial Lure, Bait, Flies _____

Hrs. Fished _____ After Interview _____

		Fish Caught After Interview
No. Fish Kept _____	Rainbow _____	_____
	Brown _____	_____
	Whitefish _____	_____
	Other _____	_____
No. Fish Released _____	Rainbow _____	_____
	Brown _____	_____
	Whitefish _____	_____
	Other _____	_____

Completed Trip? Yes _____ No _____

Courier Printing

Figure 2. Forms used in Missouri River creel survey.

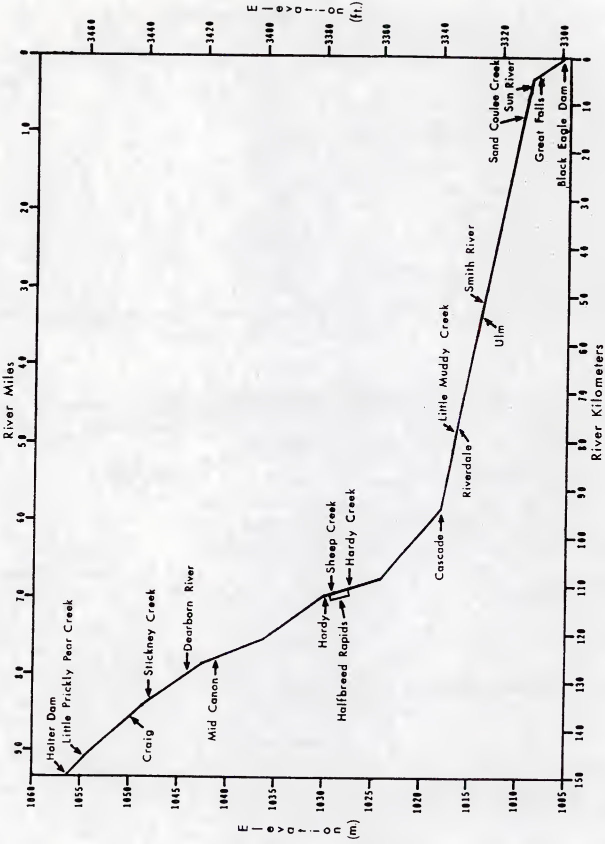

Figure 3. Longitudinal profile of the Missouri River from Holter Dam to Black Eagle Dam near Great Falls.

Water Temperatures

Water temperatures were monitored during the ice-free period by continuous recording thermographs located in the Craig, Hardy, Cascade and Ulm study sections (Figure 1). The thermographs were inoperative for a short period of time in late May and June due to unusually high runoff.

The maximum water temperatures recorded in 1981 at the Craig, Hardy, Cascade and Ulm stations were 21.7, 23.3, 21.7 and 22.2 degrees C (71, 74, 71 and 72 degrees F), respectively. These temperatures were achieved in late August (Figure 4).

Water temperature exceeded 21.1 C (70 F) on 1, 25, 3 and 7 days at the four stations, respectively, in 1981. The greater number of warm days at Hardy is related to a larger diurnal temperature fluctuation at this station, which, in turn, is probably related to the influence of the Dearborn River. Mean diurnal fluctuation of water temperature at the Hardy station was 2.79 C degrees (5.02 F degrees) compared to only 1.31, 1.06 and 1.30 C degrees (2.35, 1.90 and 2.34 F degrees) at the Craig, Cascade and Ulm stations, respectively. Diurnal fluctuations of water temperature are greater in the Dearborn River than in the Missouri River, and the Dearborn River enters the Missouri River only 3.4 km upstream from the Hardy station.

Since average minimum water temperatures at the Hardy station were consistently cooler than the other stations, mean temperatures at each of the thermograph stations follow a more logical sequence, generally warming in a downstream direction. However, the Hardy, Cascade and Ulm stations averaged only 0.43, 0.48 and 0.07 C degrees (0.78, 0.87 and 0.12 F degrees) warmer, respectively, than the Craig station.

The data essentially indicate that water temperature is optimal for trout survival from Holter Dam to Ulm. Water temperature monitoring will be continued in 1982.

MACROINVERTEBRATES

Aquatic macroinvertebrate sampling was completed during the report period. Samples have been sorted and identified, and interpretation of the data is in progress.

A total of 55,281 macroinvertebrates, representing at least 16 orders and 39 families, was collected during the study. Detailed findings will be presented in a future report.

FISH POPULATIONS

Species Composition, Distribution, and Relative Abundance

Twenty species representing eight families of fish occur in the Missouri River between Holter Dam and the confluence of the Smith River (Table 2). Rainbow and brown trout and mountain whitefish are the most common game fish, and they comprise the bulk of the sport fishery. A few burbot and walleye are found in the river; however, they are not nearly as common as the former species. Longnose and white suckers, carp, longnose dace and mottled sculpin are the prevalent nongame species.

Table 2. Fish species found in the Missouri River in Montana between Holter Dam and the confluence of the Smith River.

SALMONIDAE (Trout family)	
Prosopium williamsoni	Mountain whitefish (A)[1]
Oncorhynchus nerka	Kokanee (R)*
Salmo clarkii	Cutthroat trout (R)**
Salmo gairdneri	Rainbow trout (A)
Salmo trutta	Brown trout (A)
Salvelinus fontinalis	Brook trout (R)**
CYPRINIDAE (Minnow family)	
Cyprinus carpio	Carp (A)
Couesius plumbeus	Lake chub (C)
Pimephales promelas	Fathead minnow (C)
Rhinichthys cataractae	Longnose dace (A)
CATOSTOMIDAE (Sucker family)	
Catostomus catostomus	Longnose sucker (A)
Catostomus commersoni	White sucker (A)
ICTALURIDAE (Catfish family)	
Ictalurus melas	Black bullhead (R)
Noturus flavus	Stonecat (R)
GADIDAE (Codfish family)	
Lota lota	Burbot (C)
CENTRARCHIDAE (Sunfish family)	
Lepomis gibbosus	Pumpkinseed (R)
Micropterus salmoides	Largemouth bass (R)
PERCIDAE (Perch family)	
Perca flavescens	Yellow perch (C)
Stizostedion vitreum	Walleye (R)
COTTIDAE	
Cottus bairdi	Mottled sculpin (A)

1 Relative abundance - A=Abundant, C=Common, R=Rare.
* Rare transients found in the river, apparently from Helena Regulating Reservoir.
** Common in some tributaries of the Missouri in the study area.

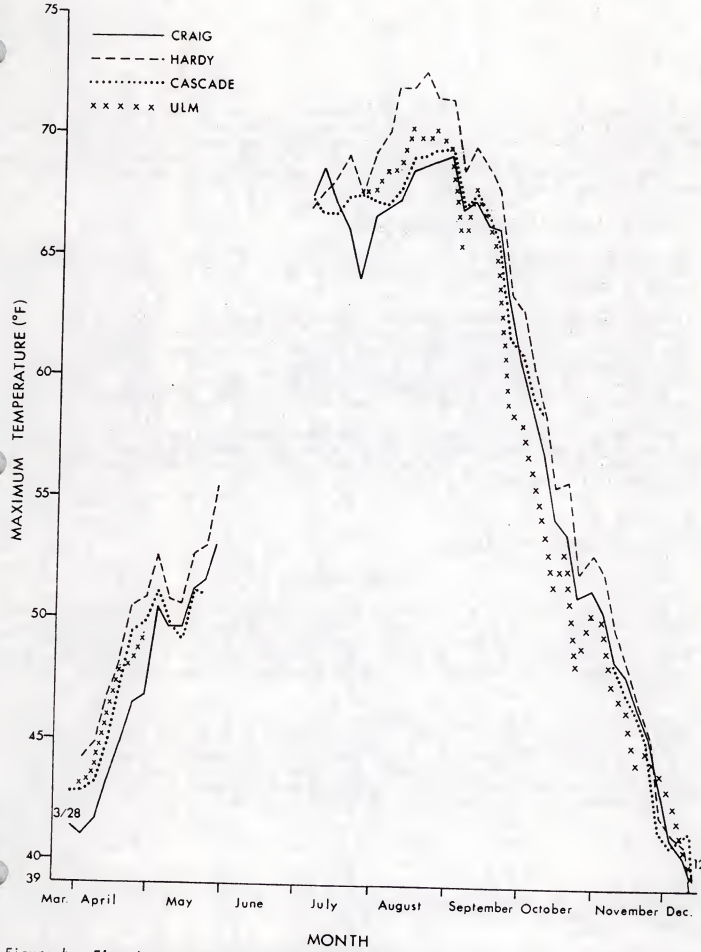

Figure 4. Five-day average maximum water temperatures for the Missouri River near Craig, Hardy, Cascade and Ulm in 1981.

No particular longitudinal distribution pattern has been found for most game or nongame fish species sampled during our study. Most species occurring in the river are found throughout the entire length of the study area from Holter Dam to the Smith River. Surveys are being continued to better define relative abundance, longitudinal distribution and species composition. Findings on these parameters will be presented in the completion report for this project.

Trout Population Estimates and Growth Rates

Trout populations were estimated in a 9.2 km reach of the Hardy section in fall 1981 and spring 1982. Trout populations were also estimated in a 6.2 km reach of the Cascade section in fall 1981.

All of the population estimates were successfully completed. The data have been keypunched and verified. Parameter cards have been prepared and sent to the Computer Sciences Center at Montana State University for computing the final estimates. Population estimate statistics will be presented in the next progress report. Age class assessments indicate spring population estimates can be made for at least two distinct age classes, while fall estimates can be made for at least three distinct age classes.

A comparison of the length-frequency distributions of rainbow trout sampled during the estimates indicates rainbow trout growth is better in the Cascade section than in the Hardy section (Figure 5). The sample of brown trout from the study sections was too small for a valid comparison.

Spawning and Recruitment Studies

Salmonid Spawning

Most members of the trout family migrate during the spawning season in search of suitable spawning sites (Hubbs and Lagler 1970). Spawning movements of lake dwelling salmonid populations into inlet or outlet streams have been extensively documented for rainbow (Rayner 1942, Hartman et al. 1962, Calhoun 1966, Scott and Crossman 1973) and brown trout (Fenderson 1958, Stuart 1957) and mountain whitefish (Snyder 1918, Calhoun 1966).

Less information is available on spawning movements of river dwelling salmonid populations into feeder streams. Calhoun (1966) reports resident rainbow trout populations in streams tend to move upstream, and if possible into tributaries to spawn. River dwelling brown trout in Ontario normally seek tributary streams for spawning purposes (MacKay 1963). Spawning movements of mountain whitefish from larger streams into some tributaries have been observed in Montana (Liebelt 1970, Brown 1971).

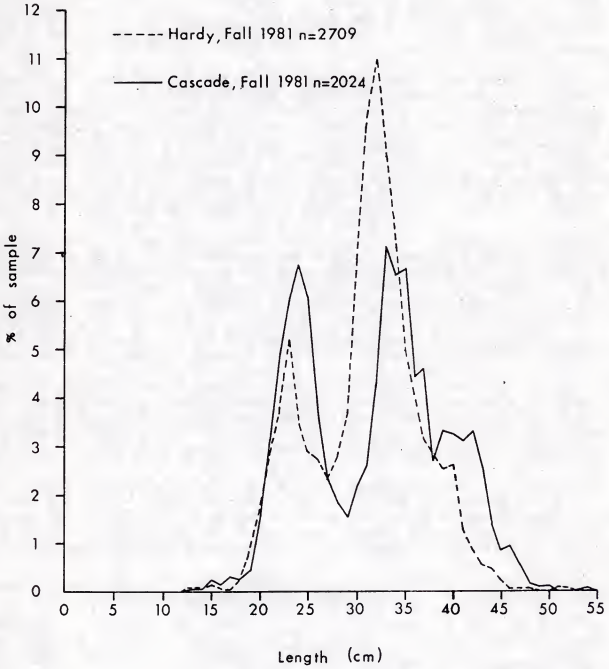

Figure 5. A comparison of the length-frequency distributions of rainbow trout sampled in t Hardy and Cascade sections during fall 1981.

In an effort to better understand the relationship between the Missouri River and its feeder streams, the lower reaches of several tributaries were electrofished during brown trout and mountain whitefish spawning seasons to document the possible presence of spawning runs. The tributaries were electrofished prior to the spawning runs to determine the size and abundance of resident salmonids. Fish captured in the tributaries during the spawning season were assumed to be from the Missouri River if they were in a ripe spawning condition and obviously oversize or overabundant for the habitat present. Also, some fish captured in tributaries had tags attached from fish population study sections on the Missouri River which confirmed the fish's origin.

Our sampling efforts on each tributary during the salmonid spawning migration periods were very limited. Numbers of spawners given in this report represent only a small portion of the total runs, since only selected days during the spawning period were sampled and only one capture run was made on each day sampled. Also, the sections surveyed represent only a small portion of the total spawning area available on most tributaries. Therefore, in the tributary streams where migrant salmonids were captured, our data document only the presence of a run and do not necessarily reflect its magnitude. In tributary streams where no migratory fish were found, more intensive sampling is needed to definitely confirm the presence or absence of spawning runs.

The lower reaches of Little Prickly Pear, Sheep, Rock, Wegner, Hardy, Stickney and Prewett creeks and the Dearborn River were electrofished in 1981 to document the possible presence of rainbow and brown trout and mountain whitefish spawning runs. All of the tributaries contained enough flow to sustain spring spawning runs, but only Little Prickly Pear and Sheep creeks and the Dearborn River contained enough flow to sustain fall spawning runs. The Smith and Sun rivers also contained enough flow to sustain spring and fall spawning runs; however, these tributaries are located at and below the lower boundary of our study area and were not included in the survey.

Electrofishing evidence indicates rainbow and brown trout and mountain whitefish utilize tributaries for spawning if they contain enough flow to sustain spawning runs (Table 3). Tag return evidence indicates trout may move considerable distances in the Missouri River to reach a spawning tributary. Tabular data on spawning movements defined by tag returns will be presented in the completion report for this project.

In addition to tributary streams, rainbow and brown trout and mountain whitefish utilize the mainstem of the Missouri River for spawning. Side channels, in particular, provide an abundance of suitable spawning habitat. It appears tributaries are relatively more important for rainbow spawning, while side channels of the Missouri are relatively more important for brown trout. Mountain whitefish spawn abundantly in both areas.

Trout Redd and Larval Fish Studies

The Missouri River and the lower reaches of tributaries were searched extensively in the spring and fall of 1981 for rainbow and brown trout redds. Numerous redds were located. A variety of physical characteristics were measured at each of the redd sites to define conditions required for spawning.

Table 3. Numbers of mature rainbow and brown trout and mountain whitefish sampled in tributaries of the Missouri River during the spawning period in 1981.

Tributary	Date Sampled	Species	Not Ripe	Ripe Male	Female			Total
					Gravid	Ripe	Spent	
L. Prickly Pear Cr.	4/3/81	rainbow trout	2	17	10	3	2	34
	4/9/81	" "	15	13	42	3	7	80
	11/19/81	brown trout	7	6	2	2	8	25
	"	mountain whitefish	2	22	-	12	5	41
Dearborn River	4/7/81	rainbow trout	21	24	38	1	0	84
	4/22/81	" "	23	13	10	4	31	81
	10/23/81	brown trout	1	0	1	0	0	2
	"	mountain whitefish	14	19	0	1	0	34
	11/6/81	brown trout	0	1	1	0	0	2
	"	mountain whitefish	7	21	2	8	8	46
Sheep Creek	3/26/81	rainbow trout	10	36	40	3	0	89
	4/10/81	" "	6	39	24	6	5	80
	5/4/81	" "	5	9	2	0	6	22
	10/21/81	brown trout	1	2	1	1	0	5
	"	mountain whitefish	0	1	0	2	0	3
	11/20/81	brown trout	6	4	0	3	9	22
	"	mountain whitefish	1	12	0	0	0	13
Rock Creek	4/6/81	rainbow trout	3	2	0	0	0	5
Wegner Creek	4/6/81	" "	0	7	0	0	1	8
Hardy Creek	4/7/81	" "	0	3	0	0	0	3
Stickney Creek	4/8/81	" "	4	24	2	2	2	34
Prewett Creek	4/9/81	" "	None observed					

Larval fish samples were collected from the Missouri River and the lower reaches of its tributaries in 1981 to determine timing and location of hatching and emergence of important fish species. Brown trout and mountain whitefish emerged mainly in late April, rainbow trout peaked by mid-May, Catostominae hatched in late May and June, and Cyprinidae emergence peaked in July.

Detailed analysis and interpretation of trout redd and larval fish data are in progress. Tabular data and a complete write-up of findings will be presented in a future report.

Trout Rearing

Missouri River

Electrofishing surveys were made in side channels of the Missouri River in 1981 to aid in determining the amount of flow required to maintain trout rearing habitat. Juvenile trout habitat preferences were identified in 1980 (Berg 1981b). Flow requirements for trout rearing were incorporated into an instream flow claim filed on the Missouri River in December 1981. The instream flow claim will be discussed later in this report.

Tributaries

Electrofishing surveys were made on the lower reaches of the Dearborn River and Little Prickly Pear, Sheep and Rock creeks in 1981 to evaluate the importance of the tributaries as rearing areas for YOY and yearling trout. Scale samples were collected from a representative sample of the juvenile fish for age determination.

A composite average of 0.44 YOY rainbow trout per electrofishing minute (trout/min) was collected compared to only 0.26 brown trout/min (Table 4). For yearling fish, averages of 0.11 rainbow and 0.04 brown trout/min were sampled. Thus, tributaries appear to be more important as rearing areas for rainbow trout than brown trout. In addition, the data suggest that a significant percentage of rainbow trout rear in the tributaries as YOY and yearlings, while a greater percentage of brown trout yearlings emigrate from the tributaries to the Missouri River. These findings are consistent with tributary rearing observations in 1980 (Berg 1981b).

Forage Fish

Forage fish were collected by electrofishing and seining. The most common forage species collected in 1981 were YOY mountain whitefish, YOY longnose and white suckers, juvenile yellow perch, mottled sculpin and longnose dace. Forage fish were generally more abundant in the lower river (Cascade and Ulm sections) than in the upper river (Craig and Hardy sections). Similar observations were made in more detailed forage fish studies conducted in 1980 (Berg 1981b).

Angler Harvest as Indicated by Tag Returns

A total of 7889 game fish has been marked with individually numbered Floy T-tags since the inception of this study on April 1, 1980. Of this total, 6883 have been

Table 4. Numbers of young-of-the-year (YOY) and yearling trout sampled in four tributaries of the Missouri River in 1981.

Tributary	Date Sampled	Minutes Electrofished	Section Length (m)	Rainbow Trout				Brown Trout			
				Number Sampled	Length Range (mm)	Average Length (mm)	CPUE[1]	Number Sampled	Length Range (mm)	Average Length (mm)	CPUE[1]
				YOY				YOY			
L.Prickly Pear Cr (Lahti Sec)	4/9	115	1500	0	-	-	0	0	-	-	0
	8/18*	100	210	33	56-105	75.6	0.33	118	68-112	87.9	1.18
	11/19	115	1500	3	83-89	86.0	0.03	10	94-127	114.5	0.09
L.Prickly Pear Cr (Sentinel Sec)	4/3	105	400	0	-	-	-	0	-	-	0
	8/17*	45	170	6	58-74	67.0	0.13	20	70-97	84.6	0.44
	11/19	30	120	0	-	-	0	0	-	-	0
L.Prickly Pear Cr (Quarry Sec)	8/17*	25	75	23	35-73	51.4	0.92	9	73-98	88.6	0.36
Sheep Cr	3/26	125	253	0	-	-	0	0	-	-	0
	4/10	60	320	0	-	-	0	0	-	-	0
	5/4	50	180	0	-	-	0	0	-	-	0
	8/13*	120	180	342	42-99	59.8	2.85	111	50-104	69.0	0.93
	10/21*	100	220	210	44-103	75.0	2.10	67	68-112	85.0	0.67
	11/20*	35	80	80	51-108	75.1	2.28	29	74-119	89.9	0.83
Dearborn R	4/7	200	7000	0	-	-	0	0	-	-	0
	4/22	200	7000	0	-	-	0	0	-	-	0
	8/12*	200	7000	2	49-67	58.0	0.01	41	62-100	78.9	0.21
	10/23*	200	7000	39	75-115	91.9	0.20	25	81-126	100.8	0.13
	11/6	200	7000	0	-	-	0	0	-	-	0
Rock Cr	4/6	50	240	0	-	-	0	0	-	-	0
	8/18*	20	60	0	-	-	0	9	60-107	88.7	0.45

Table 4. Continued

Tributary	Date Sampled	Minutes Electrofished	Section Length (m)	Rainbow Trout				Brown Trout			
				Number Sampled	Length Range (mm)	Average Length (mm)	CPUE[1]	Number Sampled	Length Range (mm)	Average Length (mm)	CPUE[1]
				Yearling				Yearling			
L. Prickly Pear Cr (Lahti Sec)	4/9	115	1500	1	185	185	0.01	1	155	155	0.01
	8/18*	100	210	38	136-197	169.9	0.38	3	161-187	169.7	0.03
	11/19	115	1500	0	-	-	0	7	132-153	138.1	0.06
L. Prickly Pear Cr (Sentinel Sec)	4/3	105	400	3	103-112	108.3	0.03	2	100-112	111.0	0.02
	8/17*	45	170	9	127-190	165.0	0.20	2	181-188	184.5	0.04
	11/19	30	120	1	192	192	0.03	0	-	-	0
L. Prickly Pear Cr (Quarry Sec)	8/17*	25	75	0	-	-	0	0	-	-	0
Sheep Cr	3/26	125	253	12	68-137	91.4	0.10	2	120-150	135.0	0.02
	4/10	60	320	3	77-101	86.0	0.05	0	-	-	0
	5/4	45	180	14	76-110	91.5	0.31	4	91-102	95.3	0.09
	8/13*	120	180	27	104-155	130.0	0.23	6	119-134	126.0	0.05
	10/21*	100	220	20	113-168	139.2	0.17	11	118-186	148.4	0.09
	11/20*	35	80	14	113-175	146.8	0.40	9	125-165	146.0	0.28
Dearborn R	4/7	200	7000	5	167-187	178.6	0.03	0	-	-	0
	4/22	200	7000	1	163	163	0.01	0	-	-	0
	8/12*	200	7000	3	161-187	170.6	0.02	0	-	-	0
	10/23*	200	7000	12	150-199	173.1	0.06	0	-	-	0
	11/6	200	7000	2	140-167	153.5	0.01	0	-	-	0
Rock Cr	4/6	50	240	6	95-143	122.7	0.12	4	125-153	135.5	0.08
	8/18*	20	60	0	-	-	0	2	184-197	190.5	0.10

1 - CPUE = No. fish sampled per electrofishing minute.
* - Sample date spent specifically searching for juvenile fish.

tagged in the mainstem of the Missouri, and 1006 have been tagged in tributaries. The species tagged include 6100 rainbow, 1753 brown, 3 brook and 2 cutthroat trout, 17 burbot and 14 walleye.

An indication of angler harvest of rainbow and brown trout in the Missouri River and its tributaries is being provided by angler-returned fish tags. Since very few game fish other than rainbow and brown trout have been tagged, data for other species are not significant enough to warrant interpretation.

A total of 6.01% of the rainbow trout tagged in the mainstem of the Missouri River has been harvested by anglers (Table 5). In tributaries, anglers have harvested 2.32% of the tagged rainbow trout. Harvest rates for brown trout are 5.96 and 3.43% in the mainstem and tributaries, respectively. In total, anglers have harvested 5.70% of the brown trout tagged in the Missouri River and its tributaries compared to 5.49% of the rainbow. This finding was not anticipated, since most anglers believe brown trout are more difficult to catch than rainbow trout.

Since large numbers of tagged trout are still at large in the study area, harvest rates presented in this report are preliminary. Angler harvest rate statistics will be updated in the next progress report.

Missouri River Creel Survey

A creel survey was conducted from April through November 1981 on the sport fishery which exists in the blue ribbon segment of the Missouri River from Holter Dam to the confluence of the Smith River. The emphasis of the survey was to evaluate seasonal and longitudinal variation in catch and harvest rates of rainbow and brown trout. Study sections for the creel survey are identical to those shown in Figure 1, except the Craig section was divided into two creel survey sections. The Holter creel survey section extended from Holter Dam to the Wolf Creek Bridge, and the Craig creel survey section extended from the Wolf Creek Bridge to Craig.

The catch rate ranged from a low of 0.16 trout per man-hour (trout/hr) in May to a high of 0.64 trout/hr in October (Table 6). For all months combined, anglers caught 0.39 rainbow trout/hr compared to only 0.02 brown trout/hr. About 69% of the anglers interviewed in 1981 were from Great Falls.

The catch rate for rainbow trout was fairly uniform from Holter to Cascade, but dropped significantly at Ulm (Table 7). The catch rate for brown trout increased in a downstream direction from 0.01 fish/hr at Holter to 0.11 fish/hr at Cascade. The catch rate dropped to 0.01 brown trout/hr at Ulm.

The success rate was significantly higher in 1981 for lure and fly fishermen than for fishermen who used bait or a combination of various methods (Table 8). Lure and fly fishermen caught 0.62 and 0.84 trout/hr, respectively, compared to only 0.37 and 0.31 trout/hr for bait and combination anglers. Brown trout comprised slightly more than 10% of the catch for lure and fly fishermen. Boat fishermen caught 0.61 trout/hr compared to only 0.38 trout/hr for bank fishermen.

Table 5. Preliminary estimates of angler harvest of rainbow and brown trout as indicated by tag returns through August 1, 1982.

Missouri River Study Area	Rainbow Trout			Brown Trout		
	Number Tagged	Number Harvested	Percent Harvested	Number Tagged	Number Harvested	Percent Harvested
Craig Section	1550	92	5.94	393	22	5.60
Hardy Section	2395	168	7.01	522	44	8.43
Cascade Section	820	38	4.63	450	22	4.89
Ulm Section	473	17	3.59	213	6	2.82
Subtotal	5283	315	6.01	1578	94	5.96
Tributary Study Area						
Sheep Creek	113	3	2.65	31	1	3.23
L. Prickly Pear Cr	461	8	1.74	129	5	3.88
Dearborn River	250	6	2.40	11	0	0.00
Rock Creek	3	0	0.00	4	0	0.00
Wegner Creek	6	0	0.00	0	-	-
Hardy Creek	2	0	0.00	0	-	-
Stickney Creek	27	3	11.11	0	-	-
Subtotal	862	20	2.32	175	6	3.43
Grand Total	6100	335	5.49	1753	100	5.70

Table 6. Monthly variation in catch and harvest rates of rainbow and brown trout as indicated by creel survey data collected from April through November 1981.

Creel Survey Statistics	Apr	May	June	July	Aug	Sept	Oct	Nov	Total
No. anglers interviewed	230	69	486	464	734	178	238	122	2521
Avg hrs fished/angler	2.95	3.51	4.12	3.79	3.97	3.88	3.92	2.77	3.79
Fish caught/man hour									
Rainbow trout	0.20	0.16	0.47	0.27	0.38	0.40	0.59	0.54	0.39
Brown trout	0.03	0	<0.01	0.01	0.02	0.02	0.04	0.05	0.02
Total trout	0.23	0.16	0.48	0.28	0.40	0.42	0.64	0.60	0.41
Fish harvested/man hour									
Rainbow trout	0.17	0.16	0.43	0.25	0.28	0.25	0.40	0.35	0.31
Brown trout	0.03	0	<0.01	0.01	0.01	<0.01	0.02	0.01	0.01
Total trout	0.19	0.16	0.43	0.25	0.29	0.26	0.42	0.36	0.32
Composition of Catch									
% Rainbow trout	87.7	100.0	99.5	96.1	95.1	94.8	93.3	91.0	95.6
% Brown trout	12.3	0	0.05	3.9	4.9	5.2	6.7	9.0	4.4
Angler Residency									
% Local[1]	1.3	0	2.1	1.7	1.4	3.4	1.7	4.1	1.8
% Great Falls	83.0	62.3	77.6	66.8	63.9	59.0	64.3	73.0	68.9
% Helena	7.4	11.6	4.7	4.5	9.3	12.9	9.2	9.0	7.7
% Other Montana	5.7	26.1	9.9	8.4	12.4	14.0	13.4	9.8	11.0
% Out-of-State	2.6	0	5.8	18.5	13.1	10.7	11.3	4.1	10.6

1 - Local - Wolf Creek, Craig, Hardy, Cascade and Ulm.

Table 7. Longitudinal variation in catch and harvest rates of rainbow and brown trout as indicated by creel survey data collected from April through November 1981.

Creel Survey Statistic	Creel Survey Section					
	Holter	Craig	Hardy	Cascade	Ulm	Total
No. Anglers Interviewed	1374	581	410	55	101	2521
Avg. Hrs fished/angler	4.23	3.62	2.93	2.66	2.87	3.79
Fish caught/manhour						
Rainbow trout	0.41	0.39	0.37	0.48	0.09	0.39
Brown trout	0.01	0.03	0.04	0.11	0.01	0.02
Total trout	0.41	0.42	0.41	0.59	0.10	0.41
Fish harvested/manhour						
Rainbow trout	0.36	0.24	0.26	0.14	0.08	0.31
Brown trout	<0.01	0.01	0.02	0.01	0.01	0.01
Total trout	0.36	0.25	0.28	0.16	0.09	0.32
Composition of catch						
% rainbow trout	98.5	91.8	91.0	81.4	89.3	95.6
% brown trout	1.5	8.2	9.0	18.6	10.7	4.4

Table 8. A comparison of the success rates of anglers using various methods and modes of fishing in 1981.

	No. of Anglers	% of Anglers	Avg. Hrs Fished/ Angler	Fish caught/man hour			Composition of catch	
				Rainbow	Brown	Trout	% Rb	%LL
Method:								
Bait	1571	62.8	4.14	0.36	0.01	0.37	98.5	1.5
Lure	140	5.6	2.89	0.55	0.08	0.62	87.4	12.6
Fly	208	8.3	3.42	0.75	0.10	0.84	88.6	11.4
Comb.	583	23.3	3.21	0.30	0.02	0.31	94.7	5.3
Mode:								
Bank	305	12.1	3.81	0.37	0.01	0.38	97.1	2.9
Boat	2216	87.9	3.59	0.54	0.07	0.61	88.2	11.8

INSTREAM FLOW STUDY

Adequate instream flow is essential to maintain fish populations in lentic environments. The increasing demand for Montana's limited water supplies comprises a potential threat to fishery resources that is often apparent even to casual observers. To maintain the fishery resource of the Missouri River below Holter Dam, minimum flows must be established to provide adequate spawning areas for adult fish, rearing areas for juvenile fish and sufficient food producing and cover areas for fish of all sizes.

A 1969 state law (Section 89-801, RCM 1947), the so-called "Murphy's Law," authorized the Montana Department of Fish, Wildlife & Parks (DFWP) to appropriate water for instream uses on 12 high quality trout streams in the state. On the Missouri River between Holter Dam and the confluence of the Smith River, DFWP filed a claim for 84.96 m^3/sec (3,000 cfs) from January 1 through December 31. As a result of a decision concerning a contested water right on one of the 12 "Murphy's Right" streams, it was determined that DFWP had an instream right, but it was not adequately quantified. Consequently, fish and wildlife data supporting the instream flow claims on all "Murphy's Right" streams had to be gathered before the claims could become effective. Senate Bill 76, entitled "An Act to Adjudicate Claims of Existing Water Rights in Montana," was passed by the 1979 Montana Legislature. This act formally required quantification of DFWP's existing instream flow rights on the "Murphy's Right" streams and established January 1, 1982 as the deadline for refiling to confirm existing rights.

In 1981, studies were completed to determine the amount of flow required to maintain the fishery of the Missouri River from Holter Dam to the confluence of the Smith River. Our claim was filed with the Montana Department of Natural Resources prior to the January 1, 1982 deadline. A complete copy of this claim will be included in the completion report for this project.

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